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The UK's Participation in Global Value Chains and Its Implications for Post-Brexit Trade Policy*

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Abstract

The aim of this paper is to provide quantitative information about the position of the UK in the network of global value chains (GVCs) and to discuss its implications for the UK's post-Brexit trade policy. We find that the UK has become much less integrated into global production networks than other EU countries over the period 2000–14, and is almost unique among EU countries in that the domestic content of its exports increased over this period. This reflects

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JEL classification numbers: E01, E16, F14, F23, L14.

the relatively high and growing domestic service content in UK exports. As a result of this, reducing the UK's tariffs on imported goods is unlikely to have a large direct effect on the average export competitiveness of UK firms. Potentially more significant for the UK is how future trade barriers with the EU are likely to affect its participation in cross-country value chains that meet final demand in markets in North America and East Asia. Such indirect exports are not captured in conventional trade statistics and can only be analysed using a GVC approach. Our findings suggest that the UK will benefit only to a limited extent from bilateral trade agreements with countries outside the EU (a 'Global Britain' strategy) if it gives up its role in the supply chains that service these countries via the EU hub.

Policy points

- It is often argued that a key benefit to the UK of leaving the EU Customs Union would be that it would gain the ability to reduce tariffs on imported inputs and so improve the competitiveness of its exporters. However, the gains from such a policy are likely to be small, because the foreign value added content in UK exports is relatively low and because the tariffs that the EU currently imposes on intermediate goods used by UK industries if imported from outside the EU are quite small. Particular sectors would be affected relatively more than others.
- Over the period 2000–14, the UK has become increasingly specialised in exporting services. Membership of the EU Customs Union, or access to a Single Market for goods (as in the UK government's recent 'Chequers' proposals), will therefore only reduce the negative economic consequences of Brexit to a limited extent.
- Part of UK exports to the EU are final products and also consumed in the EU. But exported goods and services from the UK are also used as intermediate inputs in production in the EU, and exported again to countries outside the EU.
- Taken together, these findings have important implications for the strategy of disengaging with the EU in order to gain greater access for the UK's exporters to rapidly growing markets elsewhere (a strategy known as 'Global Britain'). Unilateral tariff reductions are not likely to have large effects on exporting firms' input costs on average. Moreover, a loss of access to EU markets may discourage UK firms from participating in value chains with nodes in the EU currently exporting significant amounts to China and other fast-growing economies.

I. Introduction

Over the last few decades, the production of goods and services has become more and more internationally fragmented as countries have tended to

specialise in particular activities within a production ('value') chain. The growth of global value chains (GVCs) means that a country's industries increasingly import unfinished components or business services to produce goods and services which are in turn exported elsewhere. These trends have made the nature of international trade ever more complicated and interconnected. For example, the immediate destination of a country's exports may not be the same as the country where the final demand for those exports ultimately comes from. In addition, a country's access to imports may contribute to the competitiveness of its exporters. These facts have important implications for discussions of countries' bilateral trade deficits, the effects of exchange rate realignments and the impacts of trade barriers. For instance, by increasing the price of imported inputs, tariffs and exchange rate depreciations will make exports that embody these imported products more expensive as well.[1]

The rise of global value chains is naturally also important for assessing the potential impacts and opportunities to the UK following its vote to leave the European Union (EU) in June 2016. Supply chains form an important component of EU–UK trade, with intermediate goods and services accounting for a majority of both the UK's imports from and its exports to the EU.[2]

The aim of this paper is to provide quantitative information about the position of the UK in GVCs and to set out its implications for the UK's post-Brexit trade policy. We base our analysis on new indicators and decompositions from the trade literature that are specifically designed to illustrate the role of international production fragmentation in a country's imports and exports. Our paper is the first to apply the bilateral VAX-D and VAX-C measures set out in Los and Timmer (2018). These decompositions of a country's value added in exports can be used to illustrate the importance of global supply chains for a country's exporters, and the degree to which one country's access to particular fast-growing markets (such as China) depends on the export access of third countries to which it supplies production inputs. These are particularly important considerations for a case such as Brexit where the UK is set to move away from structures promoting economic integration within the EU, in the hope of gaining access to alternative markets through new bilateral deals (a strategy known as 'Global Britain').

While our paper sets out important facts and context for interpreting structural estimates, we do not provide new quantitative estimates of Brexit's likely economic impact.[3] Rather, we highlight salient facts that are highly relevant for future trade policy discussions, but which would not be evident without the data and methods we use.

Throughout the paper, we draw on the 2016 release of the World Input–Output Database (WIOD), which covers the period 2000–14.

[1] Johnson, 2014.
[2] Levell, 2018.
[3] For these, see Dhingra et al. (2016), for instance.

Our main findings are as follows:

- The EU is currently a significant source of production inputs for certain UK industries. Overall, the EU accounted for 9.3 per cent of UK firms' intermediate inputs in 2014. This figure was highest for the manufacturing sector, at 16.3 per cent. Within manufacturing, it tends to be higher for the UK's car, chemical, electrical, rubber and plastic, and pharmaceutical industries. These industries also export relatively more of their output to the EU.
- Despite this, however, we find that the importance of foreign value added in UK exports is low relative to other EU countries. The UK has become much less integrated in global production networks than other EU members such as France and Germany. In fact, not only did the UK have one of the highest shares of domestic value added in its exports in 2014, but it was also one of the few countries in the EU for which this ratio was increasing. This is mainly related to the increasing role of services in the export composition of the UK. In other major EU countries, services also play an important role in exports. However, in their case, a major part is due to indirect exports of services through other sectors (mainly manufacturing); thus, value added from services is embodied in exports of goods. By contrast, UK services value added is predominantly exported directly (i.e. in the form of services).
- The EU has become less important as a destination for UK value added exports over the period 2000–14. However, in 2014, still almost 40 per cent of the UK's value added exports went to the EU.
- One way for a country to improve the competitiveness of its exporters in foreign markets is to persuade other countries to lower trade barriers they apply to its exports. Another is to reduce its own import barriers to reduce the cost of foreign inputs used by domestic firms. We consider the potential effects of the second of these channels for UK exporters after Brexit. We find that neither the imposition of the EU's current 'most-favoured nation' (MFN) tariffs on UK imports from the EU, nor the removal of tariffs applied to imports from the rest of the world, is likely to have large direct effects on the input costs of UK exporters. This is partly because the MFN tariffs that the EU applies to the sort of goods UK industries use as intermediate inputs are relatively low. Particular sectors would be affected relatively more than others, however. Non-tariff barriers that may affect future imports from the EU after Brexit also pose risks for sectors that currently make use of a large amount of EU inputs.
- Part of the UK's exports to the EU are final products consumed in the EU. But exported goods and services from the UK are also used as intermediate inputs in the production of the EU's exports to other foreign markets. For instance, 14.5 per cent of UK value added that is ultimately consumed in

China is first exported in the form of intermediate inputs to producers in the EU. Aggregated over all destinations, 13 per cent of UK value added reaching its final destination outside the EU goes via exports to the EU. Figures such as these imply that, to the extent that it threatens the UK's participation in EU GVCs, Brexit could make it harder for the UK to export value added to fast-growing consumer markets. The risk of losing this part of value added exports should be subtracted from any benefits the UK might gain from the ability to sign new trade agreements with third countries after leaving the EU.

The remainder of this paper is structured as follows. In the next section, we set out what we mean by a GVC approach and describe the data sources we use. In Section III, we describe the importance of EU inputs and foreign value added for UK industries and exporters. In Section IV, we discuss how Brexit-related changes in the UK's trade policy might affect its value added exports. We first discuss the consequences of potential actions of the UK that might increase or reduce the cost of imported inputs for the export competitiveness of UK industries after Brexit. We then turn to discuss how barriers to exporting to the EU might affect the UK's participation in GVCs that meet demand in non-EU countries. Section V concludes with some implications of our analysis for the UK's future trade policy.

II. Global value chain analysis and data sources

We begin with a brief discussion of our analytical approach and of the data we use. We purposefully opt for an intuitive, non-technical presentation in the main body of the paper. We refer interested readers to the appendix (available online) for more detail on the methods we use, and to Los and Timmer (2018) for a discussion of the broader context.

1. The global value chain approach

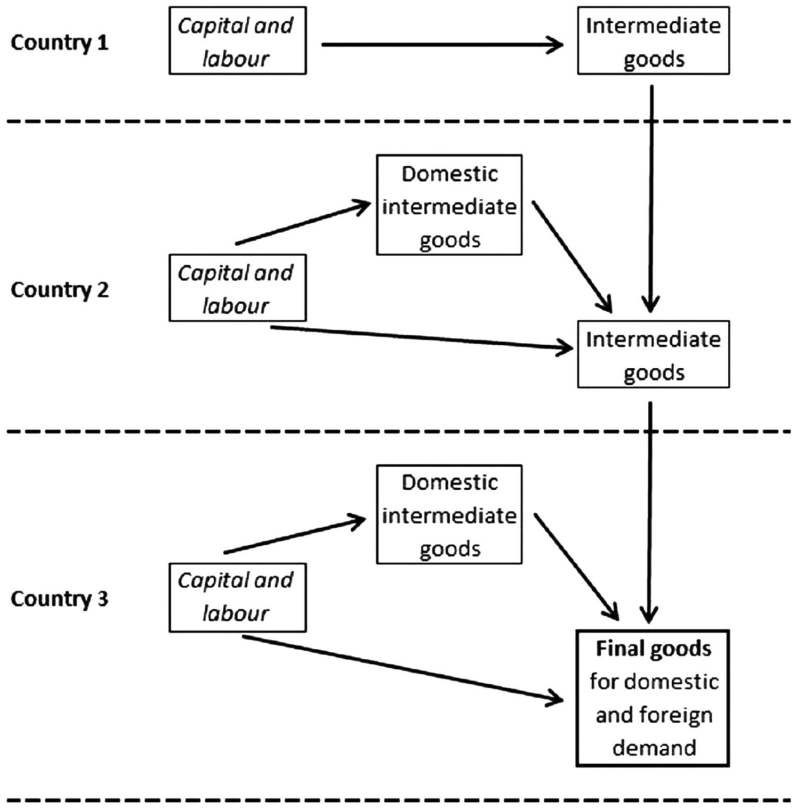
Throughout this paper, we draw on the 'global value chain' methodology as developed in Los, Timmer and de Vries (2015). The basic elements of this methodology date back to Leontief (1936).

Figure 1 (taken from Los, Timmer and de Vries (2015)) presents a stylised GVC, in which three countries participate by contributing production factors in different stages of the production process. All GVCs in this paper are identified by the country and industry in which the last stage of production takes place, before the final product is sold as a consumer product or a capital good. We will label these the 'country of completion' and the 'industry of completion' respectively.

Let us suppose for now that Figure 1 represents the GVC for cars produced in Germany (Country 3). The German car manufacturing industry itself will

FIGURE 1

Stylised representation of a global value chain



Source: Los, Timmer and de Vries, 2015.

employ labour and capital, and therefore create value added. It will also use intermediate inputs, such as business services and components. Part of these inputs are sourced in Germany itself. Labour and capital used to produce these also generate German value added. Other intermediate inputs might be imported from Country 2, which might be the UK. Let us suppose these are tyres, produced by the UK's rubber and plastics industry. This industry will add value contributing to UK GDP, as do industries selling goods or services to the British rubber industry. The UK rubber industry also purchases some of its inputs abroad, in this stylised example in Country 1. Hence, the GVC for German cars also causes value added in other countries.

In reality, GVCs have a much more complicated structure. Country 2 might import intermediate inputs from Country 3, for example. Furthermore, the last stage of production might require several components from many 'first-tier' suppliers located in a multitude of countries. In the terminology of Baldwin and

Venables (2013), such a GVC would be of the 'spider' type, whereas Figure 1 is the archetype 'snake'. In reality, GVCs are hybrids of spiders and snakes. The methods we use in this paper can cope with both. Countries participate in many value chains. In the example above, the UK was represented by Country 2, delivering intermediate inputs to the country of completion. In other GVCs, the UK acts as the country of completion, and it can also have the role of the upstream suppliers represented by Country 1 in Figure 1. In GVCs with a lot of back-and-forth trade in intermediate inputs, the UK (and sometimes even a single industry in the UK) can have several roles simultaneously.

As stressed by Timmer et al. (2013), the value added contributions of industries in countries add up to the value of the final output of the country-industry of completion. Changes in the share of value added by a country in a GVC can be interpreted as changes in national competitiveness, i.e. the ability of a country to capture part of the value created in products of which the location of the final stage of production is internationally contested. In a world in which increasing shares of intermediate inputs are imported, the share of GVC income captured by a country is a much better indicator of its competitiveness than the value of its gross exports. The GVC approach also links the economic performance of a country to the worldwide demand for (specific types of) final products.

Figure 1 also shows that the value of gross exports is often larger than the value added by the country as contained in its exports. Consider Country 2, for example. The value of its intermediate products exports to Country 3 is composed of the value it has added itself (we will follow the literature and label this VAX-D, domestic value added in exports for direct use) and the value of intermediate inputs into its own production process imported from Country 1. In a similar vein, Country 3's exports of final products do not only contain its VAX-D, but also the value of its imports from Country 2.[4] The measurement of VAX-D in exports was pioneered by Koopman, Wang and Wei (2012), while Los, Timmer and de Vries (2016) proposed a simple method to compute this indicator, which we will use in this paper. If used in a multilateral sense (i.e. VAX-D in exports to all countries is measured), the VAX-D indicator gives an impression of the degree of vertical specialisation of a country. In other words, it shows how thick or thin the domestic slices in the export bundle are. This is what we measure for the UK and other European countries in Section III.

In Section III.3, we draw on another concept, which is the value added of a country that is ultimately *consumed* in another country (i.e. that meets final demand in some export destination). Following the literature,[5] we refer to this as VAX-C. For Country 2 in Figure 1, VAX-C is the same as VAX-D.

[4]In the stylised GVC depicted in Figure 1, Country 1's VAX-D in exports and its value of gross exports are identical, since this country does not import any intermediate products.

[5]Los and Timmer, 2018.

For Country 1, however, it only includes the country's value added embedded in final goods consumed in Country 3. This measure cannot be used to indicate how dependent a country is on trade that crosses a specific border, which might be relevant when thinking about the implications of trade barriers, such as Brexit-induced tariffs between the UK and the EU. For instance, although Country 1's VAX-C to Country 3 is positive, it would not be affected by tariffs imposed by Country 3 on imports from Country 1 because the two countries do not directly trade with each other. Effects of trade barriers are best studied using VAX-D, while VAX-C provides better indications of the potential consequences of changing consumption and investment demand in a foreign country.[6] In Section IV, we apply this to understand how important the EU is as an intermediate destination for the UK when supplying to important and fast-growing consumer markets, and thus how the UK's access to these markets might be affected by potential EU–UK trade barriers.

2. Data

The analysis outlined above requires a database that links consumption and output flows within and between countries and that provides information on the compensation of production factors in the industries of which economies are composed. The data as provided in input–output tables by national statistical institutes are for individual countries and do not provide information on the bilateral trade between countries. We therefore have to rely on a data set that combines national input–output tables with bilateral trade data.

Our analysis is based on the World Input–Output Database (WIOD), which was specifically developed for global input–output analysis.[7] In what follows, we use the most recent release of the database, which includes annual world input–output tables for the period 2000–14 and distinguishes between 56 industries. The tables include data for 43 countries and a 'rest of the world' (ROW) block.[8] The database is publicly and freely available at www.wiod.org. It should be emphasised that WIOD has been constructed on the basis of official and publicly available data.[9]

[6] Johnson (2018) provides a systematic discussion of approaches to link trade and value added in a world characterised by GVCs.

[7] See Timmer et al. (2015) and Timmer et al. (2016) for detailed discussions.

[8] The 43 countries include the current 28 member countries of the EU and 15 major mature or emerging markets. Among these are China, Japan and the US. The 43 countries generate approximately 85 per cent of world GDP.

[9] A recent article by the UK Office for National Statistics (2018) reported large discrepancies between the values of UK services exports and imports as documented in official UK trade data and the values of mirror imports and exports of UK services as recorded by partner countries. According to this article, the UK trade surplus regarding services might well be smaller than suggested by the official statistics on which WIOD relies. More research by ONS and partner national statistical institutes is needed before more definitive information about the magnitudes of corrections can be given.

In a world input–output table, the product flows (both for intermediate use and for final use) are split into products that are produced domestically and those that are imported. The table also shows by which foreign industry these imported goods and services were produced. First, annual supply and use tables (SUTs) were linked using the most recent statistics on final demand categories, gross output and value added by industry from National Accounts. Thus, the world input–output tables have been constructed according to the conventions laid down by the United Nations (UN) in the System of National Accounts. The 43 national SUTs were subsequently linked to each other using detailed international bilateral trade data classified by end-use category (the so-called BEC category that splits COMTRADE data into trade of products for intermediate use, consumption or investment) and detailed import-use tables. International SUTs were combined and transformed using Eurostat's Model D[10] to create a symmetric world input–output table of the industry-by-industry type.[11]

A proper interpretation of the results requires a brief discussion of three characteristics of the data. First, the value added data are based on the location of production and not on the location of ownership. This discrepancy is most likely small for labour compensation (around two-thirds of total value added), but much less so for other income (around one-third), which includes profits. The profits of a UK-owned company as generated in production facilities in Ireland will not be reported as income to the UK, but as Irish value added. Second, re-exports have been excluded from the WIOTs, to the extent possible given official and publicly available data. Hence, we implicitly assume that re-exporting does not require any production factors.[12] Third, it should be kept in mind that the results of this analysis are not based on direct observation. Direct information on the value added distribution of a particular GVC is non-existent as firms are generally unaware of, or unable or unwilling to share, information on the value distribution in their supply chains. Our data rely on input–output tables that are constructed by national statistical institutes based on patchy information about inter-industry flows of goods and services. As such, they must be considered as an indication of broad trends only. When it comes to getting a very detailed understanding of GVC production, case studies such as Dedrick, Kraemer and Linden (2010) and Ali-Yrkkö and Rouvinen (2015) remain extremely useful.

In Sections III and IV, we will consider the UK's role in international value chains both as an importer of intermediate inputs from elsewhere and as a source of intermediate inputs for foreign industries.

[10]Eurostat, 2008.

[11]See Dietzenbacher et al. (2013) for technical details regarding the construction of the 2013 release of the WIOD tables. A few improvements have been implemented in the construction of the 2016 tables.

[12]For the Netherlands, a country that re-exports much, domestic value added in re-exports is estimated to amount to 7–8 per cent, whereas this share is about 32 per cent for regular exports (Kuypers et al., 2012).

III. Importance of foreign producers in UK supply chains

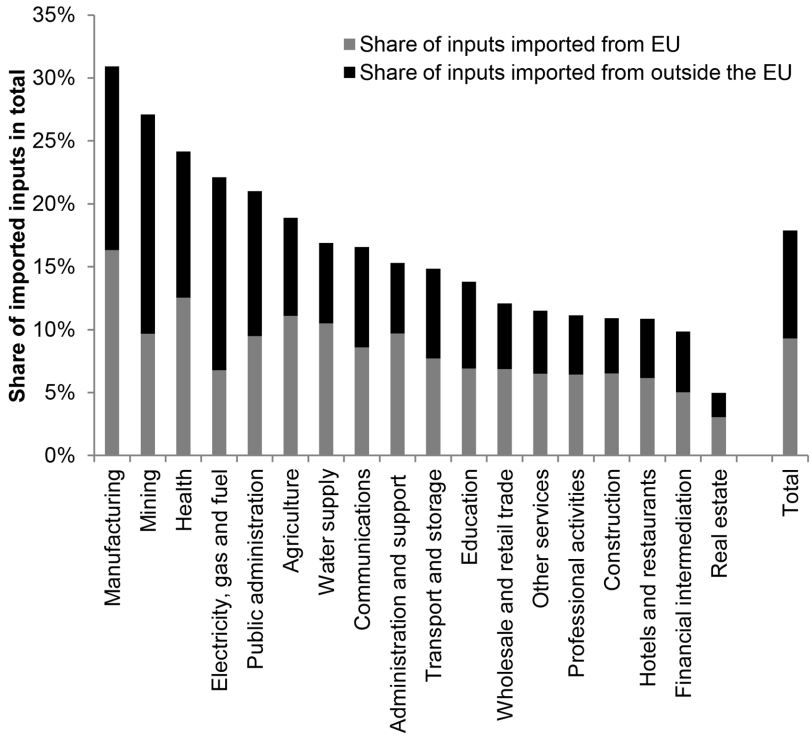
In this section, we consider the importance of foreign and EU inputs for UK firms' production and exports.

Before proceeding to a more detailed analysis of the UK's role in international global value chains, we start by examining the general importance of imports of foreign intermediate inputs for UK firms as seen through the WIOD tables.

Figure 2 shows the proportion of intermediate inputs in different UK industries that are directly sourced from overseas, and also the share imported from the EU-27. In total, 17.9 per cent of UK industries' inputs are sourced from abroad, and just over half of these (9.3 per cent) are sourced from the EU. There is notable heterogeneity across industries. The manufacturing industry is the most intensive user of foreign intermediate inputs, where they account for 30.9 per cent of the total value of intermediate inputs used by UK firms;

FIGURE 2

Share of UK inputs from abroad by industry, 2014



Source: Authors' computations based on WIOD, 2016 release (www.wiod.org).

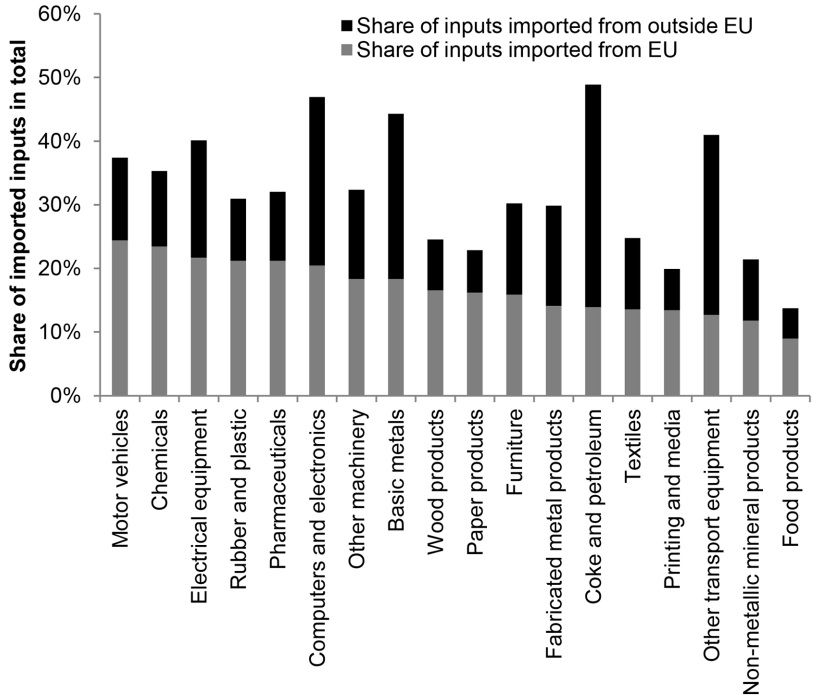
16.3 per cent of manufacturing inputs are taken from the EU. The mining and health sectors are also important users of imported inputs, which account for 27.1 per cent and 24.2 per cent of total intermediate inputs respectively. Perhaps unsurprisingly, service industries make less use of foreign inputs than other sectors.

Since Figure 2 shows that manufacturing is a key user of imported inputs, in Figure 3 we disaggregate further within this sector to see which sorts of manufacturing industries make use of more inputs from abroad. Once again, we show the total importance of imported inputs and also the share of inputs imported from the EU.

The industries that make most use of imports generally are coke and petroleum, computers and electronics, and basic metals (which, like coke and petroleum, understandably use a lot of imported raw materials). Interestingly, the industries that make use of a lot of imports are not necessarily the same as those that draw on more imports from the EU. The industries that draw most of their inputs from the EU are motor vehicles (24 per cent of inputs),

FIGURE 3

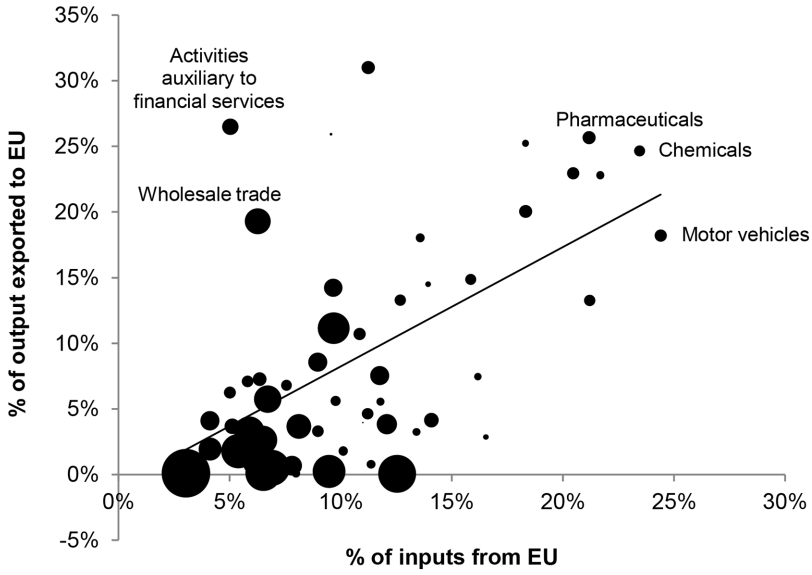
Share of UK inputs from abroad by industry, 2014



Source: Authors' computations based on WIOD, 2016 release (www.wiod.org).

FIGURE 4

Share of output exported to the EU versus share of inputs from the EU, by industry, 2014



Note: Points are scaled according to each industry's contribution to GDP.
Source: Authors' computations based on WIOD, 2016 release (www.wiod.org).

chemicals (23 per cent), electrical equipment (22 per cent), rubber and plastic, and pharmaceuticals (both at 21 per cent).

We can also look at which industries have the strongest direct import and export links with the EU. Figure 4 plots the proportion of industries' inputs that come from the EU and the proportion of each industry's output exported to the EU. Each point is scaled according to the industry's importance in the UK's overall GDP.

Figure 4 illustrates that the industries that export the most to the EU also tend to source more of their inputs from the EU. The industries that tend to both export and import relatively more from the EU are chemicals, pharmaceuticals and motor vehicles. A disruption in UK–EU trade flows is therefore likely to pose particular risks for these industries. While relatively small (directly accounting for around 2 per cent of UK GDP), these industries may have outsized importance in particular local labour markets as they tend to agglomerate in regional clusters. Examples include car plants in Sunderland and Knowsley, chemical firms located along the River Mersey and pharmaceutical firms in Hertfordshire. The presence of chemical and pharmaceutical industries in these latter locations also makes these regions

particularly intensive in research and development (R&D) spending.[13] These industries may therefore also be associated with important spillovers to the productivity of other industries.

Larger service-based industries, which contribute more to GDP, tend to fall in the lower left-hand corner of Figure 4, indicating they neither directly export to the EU nor directly import intermediate inputs from it. This is not to say that these industries would be unaffected by trade barriers between the UK and EU, however, as they may also supply services to industries that are in turn exporters (as we discuss in Section IV). A few industries export a relatively large share of their output to the EU, while not directly purchasing many EU inputs. These include 'activities auxiliary to financial services', which exports 26 per cent of its output to the EU while only purchasing 5 per cent of its inputs from the EU.

UK firms' use of EU inputs is likely to be affected by Brexit-related trade barriers between the UK and the EU. How this will in turn affect the UK firms will depend on the nature and scale of these trade barriers and on the substitutability between inputs sourced from different locations. We consider these questions in more detail in Section IV.1.

Imported inputs to production may incorporate UK value added, and intermediate inputs produced in the UK may contain foreign output. The first of these possibilities could mean that the above statistics overstate the importance of foreign suppliers in UK industries' supply chains, as imported EU inputs could in principle embed large amounts of UK content. The second means that even if a particular industry does not make great use of imported inputs, it may still be affected by trade barriers indirectly through their effects on its UK suppliers.

1. UK value added in UK exports

To account for these possibilities, we now assess more holistically the role the UK plays in international value chains, how it has changed over time and how it compares with that of its EU neighbours. To do so, we draw on the concept of 'domestic value added' in exports (VAX-D) outlined in Section II.1.

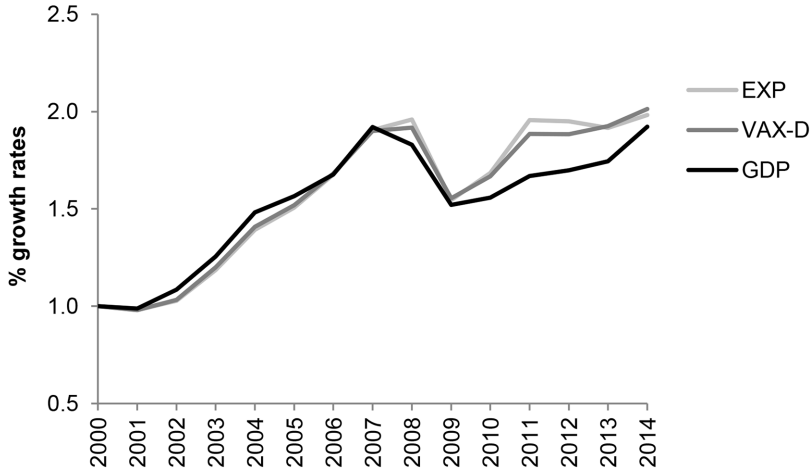
We plot the growth rates of gross exports (EXP), domestic value added in exports (VAX-D) and GDP for the UK for the period 2000 to 2014 in Figure 5. This shows that the gross export value of all goods and services has been growing quickly over these 15 years, roughly doubling over the period. Exports of domestic value added and GDP have been growing about equally rapidly.

The years 2003–08 (just before the global financial crisis) are known to have been a period in which production processes fragmented strongly. The

[13] Bernick, Davies and Valero, 2017.

FIGURE 5

Growth of UK exports, UK domestic value added in exports and UK GDP



Source: Authors' computations based on WIOD, 2016 release (www.wiod.org).

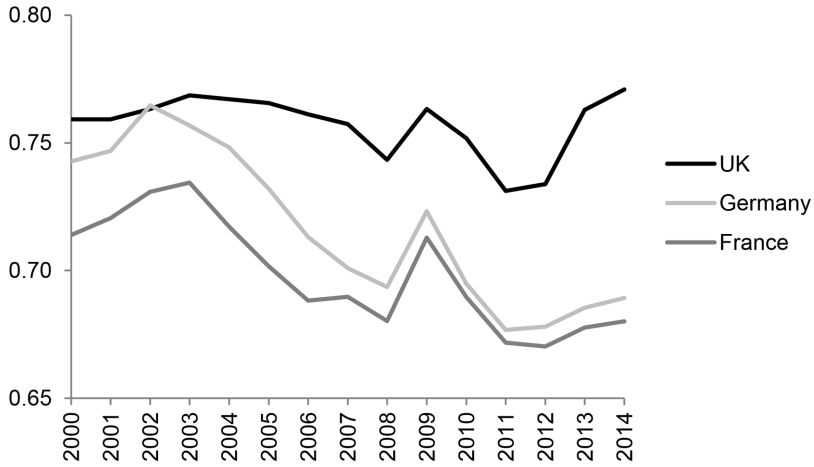
two main reasons for this were (i) vast improvements in information and communication technology and (ii) massive trade liberalisation implied by the accession of China to the World Trade Organisation and of a number of Eastern European countries to the EU.[14] As Baldwin and Venables (2013) and Los, Timmer and de Vries (2015) have shown, these tendencies are also reflected in the WIOD data. Still, Figure 5 indicates that the UK's gross exports grew roughly at the same pace as its GDP. The fact that VAX-D also grew at the same pace as exports implies that the UK did not play a role in this global tendency of increasing international fragmentation of production processes. In the immediate recovery after the crisis, exports and domestic value added in exports rebounded much faster than GDP, which implies that exports became more important as a source of GDP in that period. This trend seems to have been very short-lived, however, since GDP grew faster than domestic value added in exports in the period 2011–14. As Timmer et al. (2016) have shown, this slowdown of trade in comparison with GDP was observed in large parts of the world economy.

In their analysis of the role played by the Netherlands in the global network of value chains, Timmer and de Vries (2015) find that Dutch VAX-D grew considerably more slowly than gross exports in the 2003–08 period of rapid fragmentation of production processes. They find similar tendencies for other smaller EU countries, such as Austria, Belgium and Sweden. A comparison

[14] See, for example, Baldwin (2016).

FIGURE 6

Domestic value added in exports (VAX-D) as a share of gross exports



Source: Authors' computations based on WIOD, 2016 release (www.wiod.org).

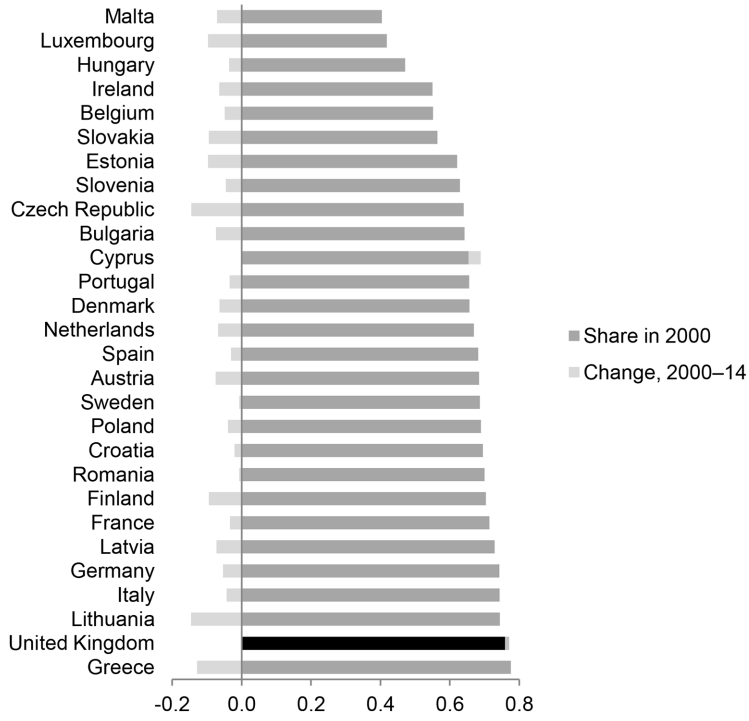
of the trends for the UK and those reported by Timmer and de Vries begs the question of whether (i) large EU countries in general played a role in the GVC network different from those played by smaller countries (which are, more or less by definition, more dependent on foreign trade) or (ii) the UK itself is an exception among larger EU economies. Figure 6 provides the answer, depicting results for the UK, France and Germany. The vertical axis indicates the share of VAX-D in the value of gross exports. The higher this value, the less exports rely on imported intermediate inputs.

In 2000, before the period of rapid international fragmentation of production processes, the VAX-D shares in exports of the three large countries considered were not too dissimilar. The domestic value added shares across the three countries even converged a bit further in the period between 2000 and 2003, to percentages between 73 and 77. Sharp divergence followed in the period prior to the 2008 financial crisis.

As Figure 6 also reveals, the VAX-D shares in exports of France and Germany declined monotonically to values below 70 per cent, while the VAX-D share in exports of the UK remained broadly constant. In the period following the crisis (2009–11), France and Germany continued to source increasing amounts of intermediate inputs used to produce exports from outside domestic markets. A similar tendency can be observed for the UK, but the pace was considerably slower. In the most recent period that we can analyse (2011–14), sometimes labelled the 'Global Trade Slowdown', the VAX-D share in exports grew much faster in the UK than in the other two large EU countries.

FIGURE 7

Domestic value added in exports (VAX-D) as a share of gross exports: EU countries



Source: Authors' computations based on WIOD, 2016 release (www.wiod.org).

Over the period 2002–14, the gap between the UK's domestic value added in exports share and the unweighted average of this share for France and Germany increased from 1.6 percentage points to 8.6, which is a clear indication that the UK economy responded very differently to the opportunities and threats related to the emergence of GVCs. In 2014, the UK used even fewer imported intermediate inputs to produce a pound of exports than it did in 2000, which makes it a clear outlier among European countries (see Figure 7, which shows that the UK had the highest VAX-D in exports share of all EU countries except Greece, and that the UK was one of only two countries with a growing VAX-D in exports share, the other being Cyprus).

One possible explanation for this result is that the UK became a relatively more isolated economy, maybe as a consequence of not participating as much in the European integration process (the UK did not adopt the euro and opted to stay out of the Schengen area). An alternative explanation relates to the composition of UK exports: the basket of UK exports may have changed in such a way that exports of products with high VAX-D in exports became more

important. In order to get more insights into the actual pattern, we computed VAX-D to gross exports ratios at the level of UK industries and compared these for 2000 and 2014.

We find that the changes varied considerably across industries. The largest increases in the share of VAX-D in gross exports appear to have occurred regarding products from the computer, electrical products and optical products industry (0.60 in 2000 to 0.68 in 2014), the wholesale, retail and repair of cars industry (0.81 to 0.85) and the textiles manufacturing industry (0.76 to 0.80). For as few as 16 (out of 56) industries, we find an increase of at least 0.005. At the other end of the spectrum, we find the coke and refined petroleum industry (0.62 to 0.43; this could partly be due to the high volatility of oil prices), the basic metals industry (0.67 to 0.53) and the other transport equipment industry (0.76 to 0.63). We find negative changes in VAX-D as a share of gross exports for as many as 30 (again out of 56) industries. These results suggest that the changing composition of the UK's export bundle has played a major role, rather than that decreasing integration in international value chains could be seen in a majority of industries. Focusing on the industries in which gross exports grew fastest (exports in 2014 minus exports in 2000), we indeed find that out of the top ten, seven industries had VAX-D to gross exports ratios in 2000 that were well above the average. The exports of the wholesale industry and the administrative and support services industry grew fastest. These industries had VAX-D in exports shares of 0.85 and 0.87 in 2000, respectively. Other prominent examples of industries that contributed a lot to the aggregate increase of VAX-D in gross exports are financial services and the industry that provides auxiliary services to the financial and insurance industries.[15] In the next subsection, we will more systematically investigate the changes in the sectoral composition of economic activity in the UK related to its exports.

2. UK sectors in the network of GVCs

We now consider the changing involvement of different broad sectors of the UK economy (services, manufacturing, and agriculture and mining) in global value chains and how this might explain the patterns in Figure 5.

We start by stressing that the value added perspective on exports also changes perspectives on the role of particular sectors in exporting activity. Approximately 41 per cent of British gross exports in 2014 were accounted for by manufacturing industries, 55 per cent by services industries and the remaining 4 per cent by agriculture and mining. When focusing on the origin

[15]The only two industries with below-average VAX-D in gross exports shares that belong to the top ten industries in which exports grew most rapidly were the basic metals industry and the car industry. The other industries in the top ten are virtually all service industries.

of the value of exports, however, the picture changes dramatically: 23 per cent of the gross export value originated outside the UK (see Figure 6), only 19 per cent was added in British manufacturing, 5 per cent by agriculture and mining and as much as 53 per cent in UK services. Most probably, part of the exported services value added is caused by export demand for output of the UK manufacturing sector. Such backward linkages can only be captured if a (global) value chain perspective is adopted.

Table 1 gives a summary picture of the sectoral origin of UK value added in its exports (in the rows) and the sector that is exporting this value added (in the columns), for 2000 and 2014. The elements on the diagonal indicate what we could call value added in 'own-sector' exports, while the off-diagonal elements are exclusively due to value chain effects. In 2014, almost all of the UK domestic value added in exports contributed by the manufacturing sector (24.9 per cent) was embodied in own-sector exports (22.9 per cent). For the services sector, this difference between its own-sector contribution to total domestic value added and its indirect contribution is larger: more than 10 per cent (i.e. 69.0% – 58.6%) of all domestic value added in exports contributed

TABLE 1

Distribution of domestic value added (VAX-D) in exports of the UK, by sector of origin and exporting sector (%)

2000

	Through exports by:			
	Agriculture and mining	Manufacturing	Services	Total
Value added from:				
Agriculture and mining	6.5	2.7	0.4	9.6
Manufacturing	0.3	36.5	1.3	38.1
Services	1.1	17.2	34.1	52.3
Total	7.8	56.4	35.7	100.0

2014

	Through exports by:			
	Agriculture and mining	Manufacturing	Services	Total
Value added from:				
Agriculture and mining	3.3	2.1	0.7	6.1
Manufacturing	0.2	22.9	1.8	24.9
Services	0.8	9.5	58.6	69.0
Total	4.4	34.5	61.2	100.0

Source: Authors' computations based on WIOD, 2016 release (www.wiod.org).

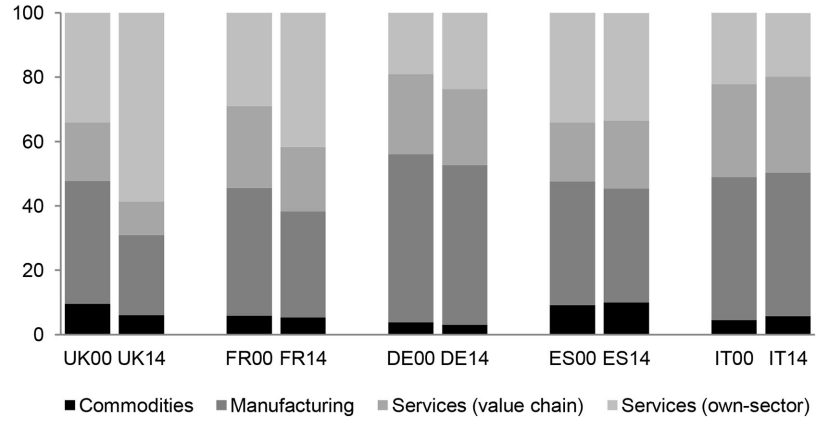
by services ended up in exports of the other two broad sectors. Note also that a sizeable proportion of the value added embedded in UK manufacturing exports is generated in the UK services sector (9.5/34.5 = 28 per cent in 2014).

If we consider changes between 2000 and 2014, we see that the share of own-sector exports in total domestic value added in exports remained rather stable for manufacturing (above 90 per cent in both years). Still, a compositional change in domestic value added in exports is clearly visible: in 2000, as much as 38 per cent of this domestic value added originated in the manufacturing sector, but this had dropped to 25 per cent in 2014. The share of the commodity-producing industries (agriculture and mining) was already low in 2000, but it declined over the period considered. The mirror image of these changes is the substantial increase in the share of VAX-D in exports generated in the services sector, from 52 per cent in 2000 to almost 70 per cent in 2014. The change in the share of own-sector exports in total domestic value added in exports in this sector deserves special attention: in 2000, this share amounted to 65 per cent (= 34.1/52.3), whereas it increased to 85 per cent (= 58.6/69.0) in 2014. Growth in the relative importance of service sector exports and the growth in service exports' use of inputs from UK service industries thus help to account for the patterns we see in Figure 5.

To understand how these changes might explain why the VAX-D share in exports of the UK evolved differently from those of other EU members, Figure 8 compares the shares of the three sectors of origin in domestic value

FIGURE 8

Shares of domestic value added in exports (VAX-D) by sector of origin, with split in services: 2000 and 2014



Abbreviations: FR: France; DE: Germany; ES: Spain; IT: Italy.
Note: 'Commodities' refers to agriculture and mining industries.
Source: Authors' computations based on WIOD, 2016 release (www.wiod.org).

added in exports for five EU members, in 2000 and 2014. For services, we make the split between own-sector exports and value chain exports explicit. The figure reveals that the UK started out in 2000 as a country not too different from the other large European countries. Germany's share of services was a bit lower (the own-sector share in particular), but the UK's shares closely resembled those of Spain, for example. Between 2000 and 2014, however, the evolution of the UK pattern has been quite unique. France is the only country among those considered here for which we also observe a sizeable increase in the share of own-sector domestic value added in exports of the services sector, but not to the extent of the UK. For the other countries, the patterns remained much more stable.

3. UK value added in exports to the EU

The EU is the most important destination for the UK's gross exports, accounting for 43 per cent of them in 2016. This was down from 54 per cent in 2000. Much of this decline has been driven by the decline in EU demand for final goods and services as a result of the 2011–13 eurozone recession. Between these years, the proportion of the UK's exports going to the EU declined from 49 per cent to 44 per cent.[16]

What happens if we consider a *value added* measure of the EU's importance as an export market? This measure takes account of the fact that UK exports may embed foreign content, and some UK value added may be exported to a particular destination through the exports of a country that makes use of UK inputs. Table 2 shows the importance of the EU and non-EU export markets in UK value added exports across different sectors.

The table shows that the UK's dependence on the EU as a destination for its exports has fallen over the period considered. Whereas 46 per cent of all UK VAX-D was contained in exports to other EU countries in 2000, this share declined to under 40 per cent in the one-and-a-half decades that followed.[17] It is noteworthy, however, that this decline was smaller than the decline in the importance of the EU for the UK's gross exports. For agriculture and mining, the change was negligible, but the shares of EU countries in both the manufacturing VAX-D and services VAX-D in exports decreased considerably: from 52 per cent to 39 per cent for manufacturing and from 42

[16] Authors' calculations using tables B6 and B6B in https://www.ons.gov.uk/economy/nationalaccounts/uksectoraccounts/datasets/unitedkingdomeconomicaccountsbalanceofpaymentscurrentaccount/current.

[17] These shares are close to gross export shares, as reported by ONS. Differences are due to different industry compositions of exports by sector to the EU and to the non-EU (industries with high VAX-D in exports might be more prominent in exports to one destination and less in exports to the other), and to steps in the construction of WIOD required to reconcile inconsistencies between data obtained from several sources.

TABLE 2

Distribution of domestic value added (VAX-D) in exports of the UK, by sector of origin and split into exports to EU and non-EU partners (%)

2000

	Through exports to:		
	EU	Non-EU	Total
Value added from:			
Agriculture and mining	4.0	5.6	9.6
Manufacturing	19.8	18.4	38.1
Services	22.2	30.1	52.3
Total	45.9	54.1	100.0

2014

	Through exports to:		
	EU	Non-EU	Total
Value added from:			
Agriculture and mining	2.5	3.5	6.1
Manufacturing	9.7	15.2	24.9
Services	26.9	42.1	69.0
Total	39.2	60.8	100.0

Source: Authors' computations based on WIOD, 2016 release (www.wiod.org).

per cent to 39 per cent for services. These trends suggest that the UK detached itself from the EU hub of many GVCs, at least if the destinations of its exports are considered.

These trends might have made the UK less vulnerable to the Brexit-induced trade barriers between the UK and the EU, though it should of course be noted that the importance of the EU as a destination for UK exports remains very significant in both gross and value added terms.

IV. Global value chains and the UK's trade policy

In this section, we consider the implications of the patterns we described in Section III for the UK's future trade policy.

1. Potential impact of UK import tariffs on the UK's export competitiveness

There are two ways that a country can seek to boost the competitiveness of its exporters through changes in its trade policy. The first is to secure reductions on import barriers other countries impose on its exports. The second,

whose potential importance for the UK was highlighted in Section III, is to reduce the trade barriers it applies to imported inputs used by domestic firms. In this subsection, we consider how the UK's post-Brexit trade policy might affect the competitiveness of UK exporters via the second of these channels.

Brexit could in principle affect the trade barriers to imported inputs in two ways. First, new trade barriers may be imposed on the UK's imports of inputs from the EU. These could raise UK firms' costs and potentially harm competitiveness. Second, the UK could, through bilateral deals or unilateral tariff reductions, reduce the cost of foreign inputs purchased from non-EU countries. In what follows, we consider how these sorts of changes could affect UK exporters by drawing on what the WIOD tables reveal about UK firms' current usage of foreign inputs.

Section III showed that foreign value added was (on average) relatively unimportant for UK exporters. By itself, this would imply that changes in the trade barriers applied to imported inputs would be unlikely to have large effects on the competitiveness of UK exporters. However, in order to understand the impacts of different Brexit scenarios on UK firms' input costs, it is important to consider not only the importance of foreign inputs, but also their composition, sources and the potential trade barriers that may apply to them. Take, for example, the impact of a 'WTO rules' Brexit in which the UK and EU failed to strike a free trade deal. Under these circumstances, tariff and non-tariff barriers would be imposed on the UK's imports from the EU. If UK firms made relatively more use of EU goods that would attract particularly high tariffs, then their costs could significantly increase even if their use of such inputs were small. Similarly, if the UK were to assert control of its own tariff schedules, then the gains from tariff reductions on imported inputs sourced from non-EU countries would depend on whether or not the inputs UK firms made use of are currently subject to especially high rates of protection.

a) Tariff changes

To understand how imposing import tariffs on EU suppliers or post-Brexit reductions of tariffs on third countries might affect UK firms' input costs, we first consider which tariffs currently apply to those industries from which the UK draws its intermediate inputs. To do this, we use the WIOD tables to separate out which sorts of imports are used as intermediate inputs by UK industries and which are used for final consumption by either firms or households. We then calculate the average tariff that would be paid on each category if the UK levied the EU's current MFN tariffs on goods imported from the EU (column 1 of Table 3) and if the EU's MFN tariffs were levied on

TABLE 3

Average MFN tariffs that would be charged on EU and non-EU imports of goods and services for intermediate and final consumption

	(1) Average MFN tariff on goods from EU	*(2) Average MFN tariff on all imports from EU*	*(3) Average MFN tariff on goods from non-EU*	*(4) Average MFN tariff on all imports from non-EU*
Intermediate	4.2%	2.6%	2.5%	1.7%
Final	9.5%	7.4%	5.9%	4.5%

Note: All tariffs are weighted by imports (by EU imports in columns 1 and 2 and by non-EU imports in columns 3 and 4). Trade-weighted tariffs by industry are calculated using COMTRADE data for 2014 (which cover all imports whether for use as intermediate inputs or for final demand) aggregated up to the 56 industry classifications in the WIOD tables. Imports of goods to the UK from the EU and non-EU countries for each industry by purpose are then taken from the WIOD tables and used to separately calculate weighted average tariffs for intermediate and final goods imports respectively. Tariffs are taken from 2016 but weighted with 2014 trade flows (the latest available year in the WIOD data). Specific duties have been converted to *ad-valorem* equivalents.

Source: Authors' calculations using WIOD (2016 release), TRAINS tariff data and COMTRADE trade database.

all imports from the EU (column 2). We do the same for imports from non-EU countries (columns 3 and 4).[18]

Tariff rates tend to be much larger for final consumption than they are for intermediate goods. While the average MFN tariff that would apply to final consumption goods imported from the EU is 9.5 per cent, the average tariff that would be charged on intermediate goods is 4.2 per cent. When we include all inputs (including imports of services, which attract no tariff), these figures fall to 2.6 per cent and 7.4 per cent respectively. This reflects the fact that intermediate goods imported by the UK tend to take the form of manufactured goods or raw materials for which the EU's current external tariffs are relatively low. The kind of intermediate goods purchased from the rest of the world attract an MFN tariff of 2.5 per cent (falling to 1.7 per cent when foreign services are included). This compares with an average MFN tariff on final goods imported from outside the EU of 5.9 per cent.

[18]In practice, the EU's various trade agreements mean that the actual tariff levied on imports from the rest of the world will be lower than this. However, exporters in countries that have preferential tariff access to the EU may raise their prices above those charged by alternative producers in countries that face the full MFN tariff rate. This would mean that using average tariffs levied on UK imports might understate the full effect of the tariff schedule on import costs.

Now we turn to the question of the extent to which the current schedule of external tariffs might affect the export competitiveness of UK industries. We can calculate a measure of the impact of tariffs on firms' input costs:

$$(1) \qquad Tariff\ costs_j = \sum_i t_i \left(\beta^{UK} a_{ij}^{UK} + \beta^{EU} a_{ij}^{EU} + \beta^{ROW} a_{ij}^{ROW}\right),$$

where a_{ij}^{UK} is the input coefficient in the technical input–output matrix giving inputs in industry j sourced from UK industry i, $a_{ij}^{EU} = \sum_{k \in EU} a_{ij}^{k}$ is the inputs from EU countries and $a_{ij}^{ROW} = \sum_{k \in ROW} a_{ij}^{k}$ is the inputs from non-EU foreign countries. t_i is the current EU ('most-favoured nation') *ad-valorem* tariff on imports in industry i.[19]

The parameters β^{UK}, β^{EU} and β^{ROW} determine the pass-through of tariff costs to the prices of UK, EU and non-EU firms respectively. In principle, these could also differ by industry. An assumption that $\beta^{UK} = \beta^{EU} = \beta^{ROW} = 1$ would imply that there is full pass-through of tariffs to both foreign and domestic prices (i.e. that, as a result of tariffs, the prices paid by UK firms for inputs are higher by the EU's current MFN tariff for each industry, regardless of where those inputs are currently sourced from). This would occur under the assumptions that the UK is a small open economy, there is perfect competition, and all imported and domestic varieties of products within an industry are perfect substitutes. Consistent with these assumptions, higher UK input costs are assumed not to affect the prices of foreign intermediate inputs which may themselves draw on UK inputs.

These assumptions are strong and counterfactual. They imply, for instance, that UK firms gain no cost advantage either through the UK's ability to trade tariff-free with the EU or from the EU's various trade agreements with third countries which reduce or eliminate bilateral tariffs. However, they allow us to calculate an upper bound for the possible impact of tariffs on firms' input costs. If we thought pass-through were incomplete, we could select lower values for the β parameters.

In what follows, we therefore consider two cases when assessing the impact of tariffs on production costs: one where $\beta^{UK} = \beta^{EU} = \beta^{ROW} = 1$ and another where $\beta^{UK} = 0$ but $\beta^{EU} = \beta^{ROW} = 1$.

Table 4 shows the proportion of firms' total input costs that are accounted for by production from domestic industries, industries in the EU-27 and industries located in the rest of the world (columns 1–3). EU inputs are most important in the manufacturing industry, which also makes most use of inputs from the rest of the world. Overseas inputs of all kinds are less important in service industries (with the exception of the health sector).

[19] Feenstra (2017) sets out a related set of measures for 'effective protection' (the impact of tariffs on firms' value added taking into account output and input tariffs).

TABLE 4

Source of direct inputs in UK industries, 2014

Industry	*Source of direct inputs*			*Tariff costs*		*Tariff and non-tariff costs*	
	(1) $\sum_i a_{ij}^{UK}$	(2) $\sum_i a_{ij}^{EU}$	(3) $\sum_i a_{ij}^{ROW}$	(4) $\sum_i t_i\left(a_{ij}^{UK}+a_{ij}^{EU}+a_{ij}^{ROW}\right)$	(5) $\sum_i t_i\left(a_{ij}^{EU}+a_{ij}^{ROW}\right)$	(6) $\sum_i (t_i + NTB_i)a_{ij}^{EU}$	(7) *Share of UK exports*
Agriculture	0.47	0.06	0.06	2.86	0.38	1.06	0.6%
Mining	0.28	0.04	0.07	0.20	0.07	0.40	3.4%
Manufacturing	0.41	0.12	0.11	1.55	0.59	1.52	40.8%
Electricity, gas and fuel	0.58	0.05	0.11	0.15	0.09	0.52	0.2%
Water supply	0.43	0.06	0.03	0.42	0.11	0.52	1.3%
Construction	0.51	0.04	0.02	0.48	0.13	0.47	0.3%
Wholesale and retail trade	0.44	0.03	0.02	0.50	0.10	0.39	11.5%
Transport and storage	0.47	0.05	0.05	0.23	0.07	0.60	4.0%
Hotels and restaurants	0.39	0.03	0.02	3.89	0.31	0.55	1.7%
Communications	0.37	0.03	0.03	0.29	0.09	0.42	5.3%
Financial intermediation	0.41	0.02	0.02	0.10	0.02	0.27	15.0%
Real estate	0.25	0.01	0.01	0.01	0.00	0.08	0.2%
Professional activities	0.35	0.03	0.02	0.20	0.05	0.30	7.2%
Administration and support	0.38	0.04	0.02	0.30	0.10	0.42	5.7%
Public administration	0.31	0.04	0.04	0.28	0.14	0.44	0.4%
Education	0.19	0.02	0.02	0.25	0.05	0.18	0.9%
Health	0.35	0.06	0.05	0.49	0.18	0.77	0.1%
Other services	0.31	0.02	0.02	0.32	0.06	0.25	1.3%
Export-weighted average	0.40	0.07	0.06	0.87	0.29	0.85	–

Source: Authors' calculations using WIOD (2016 release), TRAINS tariff data and COMTRADE trade database.

Column 4 of the table shows how much input costs would fall if all tariffs were abolished under the assumption of full pass-through of tariffs into domestic and foreign prices. As we described above, this is likely to overstate tariffs' impact on firm costs. By this measure, the largest fall in costs would be experienced by the hotels and restaurants sector, though this accounts for a small fraction of the UK's total exports (see column 7). Most significantly in terms of UK exports, the manufacturing industry would experience a reduction in costs of 1.55 per cent per unit of output. Overall, however, the gains in terms of cost reductions for exporting firms are small (with an export-weighted average of 0.87 per cent). In column 5, we assume zero pass-through to UK prices (i.e. set $\beta_{UK} = 0$). This substantially reduces the potential gain from tariff reductions, with a particularly large effect on the gains for hotels and restaurants (which source many of their inputs from the UK). The export-weighted reduction in costs falls to 0.29 per cent. Manufacturers still enjoy a reduction in costs which could be thought of as being equivalent to the elimination of a 0.59 per cent output tariff in foreign markets.

What can we say about the possible actual values of the pass-through parameters? They will depend crucially on two factors. The first is how well production inputs from the rest of the world could substitute for inputs currently purchased from suppliers in the UK and EU. This is an area where there is a great deal of uncertainty. Some studies point to considerable stickiness in firms' supply chains. For instance, studies exploiting the effects of natural disasters on firms' suppliers find that these events can have important impacts on output and sales, suggesting either that supplier relationships are highly specific and thus difficult to replicate or that there are large (short-term) search or other costs of identifying and establishing relationships with new suppliers.[20] These particular studies might be more relevant to a case where the UK imposes trade barriers on EU inputs abruptly, leaving firms only limited time to prepare (for instance, in the case where talks between the EU and the UK break down and no deal is struck to manage a transition to trading under WTO rules). In other circumstances, UK firms might have more time to adapt to new trade barriers. Another approach to assess the impact of any new trade barriers is to draw inferences based on empirically estimated trade elasticities. Accounting for estimates of the relevant elasticities within a larger computable general equilibrium model, Dhingra et al. (2016) find that unilateral tariff reduction would only reduce the costs of a WTO rules Brexit in terms of GDP by 0.3 percentage points.

A second factor that will determine the effect of tariff reductions on input costs is the degree to which firms pass on costs to end consumers rather than increasing their markups. De Loecker et al. (2016) study the pass-through of tariff reductions to firm margins in the context of trade liberalisation in India

[20]Boehm, Flaaen and Pandalai-Nayar, 2015; Barrot and Sauvagnat, 2016.

over the period 1989–2003, finding that average tariff reductions of 62 per cent led to an average reduction in firms' marginal costs of 31 per cent. However, because firms also raised their markups (by 13 per cent on average), these cost reductions only translated into an 18 per cent reduction in output prices. Pass-through was thus incomplete, though firms may have used profits to finance investments in innovation and the introduction of new product varieties.

b) Non-tariff barriers

Of course, non-tariff barriers, which we have not considered in the above analysis, pose an additional and important source of risk on top of that associated with tariffs. As well as giving the UK more freedom to adjust tariff schedules, leaving the EU Customs Union will also almost inevitably lead to increased rules-of-origin checks and other customs checks on goods imported to the UK from the EU. Other non-tariff barriers caused by regulatory divergence and the need for products to conform with EU standards may be particularly important for trade in food, services and high-end manufacturing. Changes to freedom of movement between the UK and the EU may also affect the costs of service imports and further affect firms' input costs. All of these costs are likely to be more difficult to reduce in bilateral negotiations with third countries than tariff barriers.

A number of papers have shown that the effect of non-tariff barriers on trade can be substantial. Hornok and Koren (2015) find that reducing administrative barriers to trade by half would be equivalent in its effects on trade flows to a 9 percentage point reduction in tariffs and that customs unions between countries are effective at reducing these costs. Alessandria, Kaboski and Midrigan (2010) find that firms economise on per-shipment cost by importing goods in larger quantities but less frequently and that importing firms hold more goods in inventories. They find that such frictions have large *ad-valorem* tariff-equivalent costs (estimated at 20 per cent) largely due to inventory carrying expenses. Moreover, in general, the effects of tariff reductions on purchases of foreign inputs are thought to be complementary both with the effects of liberalisation in other non-tariff barriers and with foreign direct investment (since foreign firms make greater and more efficient use of imported inputs).[21] If Brexit were to increase tariffs and non-tariff barriers at the same time as discouraging foreign direct investment, its effects on trade could be compounded.

In column 6 of Table 4, we consider how UK industries' input costs might be affected by the combination of tariff and non-tariff barriers in the event of a WTO rules Brexit where the UK leaves the EU without a free trade agreement with its remaining members. To assess this, we consider the increase in firms' input costs that would occur if there were full pass-through of tariffs and costs

[21] Halpern, Koren and Szeidl, 2015.

associated with non-tariff barriers to the prices of EU inputs used by UK firms (but no impact on the costs of UK-made inputs or non-EU imports). This requires an assessment of the possible values of non-tariff barriers for different sectors. We take these from the EU Exit Analysis Cross Whitehall Briefing Paper, which expressed predicted non-tariff barriers in a WTO rules scenario as *ad-valorem* tariff equivalents in different sectors.[22] We allocate the sectors used in this analysis to the WIOD industries and include them alongside tariff costs.

Column 6 of Table 4 shows that the export-weighted average increase in input costs from a WTO rules Brexit including non-tariff barriers is nearly as great as that we attributed to the EU's external tariffs in column 4. The worst-affected industry in this case is manufacturing, which experiences a cost increase equivalent to an output tariff of 1.52 per cent. This reflects the current importance of EU inputs for manufacturing as well as the potentially high costs associated with non-tariff barriers.

2. The role of the EU as a GVC link between the UK and the rest of the world

One of the arguments for leaving the EU Customs Union as put forward by proponents of a so-called 'hard' Brexit relates to increased opportunities for the UK to strike its own trade deals with third countries. These deals could be more attractive than the deals (if any) that these countries currently have with the EU. It is often argued that many of these countries (China and India are often mentioned as prime examples) enjoy more rapid growth of consumption and investment demand than the EU. Hence, viewed from a long-run perspective, the UK would benefit from sacrificing strong trade relationships with the EU in order to develop those with other countries. This strategy has frequently been labelled 'Global Britain'.

Several studies[23] have found evidence that it is highly unlikely that UK exports to third countries will increase sufficiently to compensate for the losses in exports to the EU caused by a discontinuation of the UK's membership of the Customs Union. This is mainly due to the fact that geographic distance is still a major determinant of trade volumes. The EU is not only a large trade partner, but also a very nearby one. The much larger distances to faster-growing markets such as China and India will prevent exports to these countries increasing substantially, even if tariff and/or non-tariff trade barriers are reduced considerably.

In a world characterised by production organised in GVCs, the UK does not only benefit (in terms of the creation of value added) from the rapid

[22] This is a presentation made to the House of Commons Exiting the European Union Committee which was leaked to the media in January 2018.

[23] See, for example, Brakman, Garretsen and Kohl (2018).

increases in standards of living in a country such as China by exporting to that country. In addition, other parts of the UK value added induced by Chinese final demand enter China embodied in products imported from other countries, including those in the EU. The share of UK value added exports (VAX-C) to third countries such as China crossing borders between the UK and the EU is at risk from Brexit, since tariff and non-tariff barriers will decrease the competitiveness of these supply chains vis-à-vis supply chains that do not involve direct exports from the UK to the EU. The risk of losing this part of VAX-D should be subtracted from the opportunities to benefit from intensification of trade with third countries.

We computed the share of UK VAX-C to a third country G crossing the border between the UK and the EU in two steps. We first computed the UK value added in the production activities in the UK that can be attributed to final demand in G. Next, we repeated this procedure, starting from a modified inputs coefficients matrix in which requirements of industries in EU countries for inputs imported from the UK are set to zero.[24] The difference between the two indicators is the UK VAX-C to country G that is hampered at least once by trade barriers due to Brexit, and therefore 'exposed to Brexit'.[25]

The results are documented in Table 5. Aggregated over all destinations, the share of UK value added reaching the final destination in third countries via direct exports to the EU amounts to 13 per cent. This average share hides a lot of heterogeneity, however. For destination countries close to the EU (such as Switzerland and Turkey), the shares tend to be considerably higher, whereas value added exports to North America (Canada and the US) are less dependent on the EU hub of the global production network.

Are these shares small or large, considered from a policy perspective? We think they are large. In the extreme case in which all UK exports to the EU would come to a halt when Brexit becomes effective, about $7.6 billion UK value added exports to the US would be lost (see Table 5). In order to compensate for this loss, improved trade relationships with the US need to lead to slightly more than 10 per cent additional UK value added exports via direct exports and/or indirectly via exports to other third countries. For the second most important destination of UK value added exports (China), this increase needs to equal 17 per cent, and for Switzerland (the third most important destination country) more than 20 per cent. In view of the fact that external EU tariffs tend to be rather low already (see Table 3), we consider it unlikely that reductions of these alone will allow for the required intensifications of trade relationships with third countries. This impression is strengthened by the fact that the UK relies on services exports, for which tariffs are not the main trade

[24] See Los and Timmer (2018) and the appendix for related explanations.
[25] Chen et al., 2018.

TABLE 5

UK value added exports for consumption (VAX-C) to non-EU countries, 2014

Destination country	*UK VAX-C (US$ million)*	*UK VAX-C via the EU (US$ million)*	*Share*
United States	81,071	7,616	9.4%
China	31,007	4,508	14.5%
Switzerland	13,913	2,355	16.9%
Russia	13,344	2,046	15.3%
Canada	12,926	979	7.6%
Japan	11,801	1,578	13.4%
Australia	8,762	810	9.2%
Norway	8,011	1,047	13.1%
South Korea	7,464	901	12.1%
India	6,632	791	11.9%
Brazil	6,165	961	15.6%
Turkey	4,919	1,049	21.3%
Mexico	3,884	628	16.2%
Taiwan	2,565	383	14.9%
Indonesia	2,094	333	15.9%
Rest of the world	193,345	26,659	13.8%
Total	407,904	52,646	12.9%

Source: Authors' computations based on WIOD, 2016 release (www.wiod.org).

barrier.[26] Many experts consider it unlikely that it will be possible for the UK to strike deep trade deals with third countries that would really lower barriers to services trade, given that the EU Single Market is by far the most liberalised international market for services in the world.

V. Conclusions and policy implications

The rise of global value chains has a number of general lessons for those designing a country's trade policy. Here we set out a few of these.

- Gross exports and imports between countries can give a misleading impression of a country's access to particular export markets. For instance, by participating in international value chains, the UK can benefit from rapidly growing demand in East Asia even if the UK itself does not directly export to these markets.
- The increasingly interconnected nature of global trade means that a country's imports and exports cannot be treated as independent quantities. A successful exporting country will also need to be open to imports.

[26] See, for example, Dhingra, Freeman and Mavroeidi (2018).

Exports embed imports, and so greater access to imports can boost the competitiveness and export performance of domestic firms.

- Demand for the exports of UK industries depends not only on the export access of UK-based firms but also on the export access of firms they supply. If the UK remains an important supplier to EU firms, the trade deals the EU signs will continue to have relevance for the UK in the coming years, whether or not the UK leaves the Customs Union. This includes, of course, the access the EU has to the UK market.

The UK's current position in GVCs also has specific lessons for the UK's post-Brexit trade policy. A key objective behind the UK government's current aim of leaving the EU Customs Union is to increase the UK's exports to fast-growing emerging economies, potentially through reductions in tariffs on firms' inputs and by signing its own bilateral deals with these economies. However, absent a radical shift in the composition of the UK's exports after Brexit, the high content of domestic services in UK exports limits the potential for tariff reductions to boost UK firms' export competitiveness. This strong specialisation of the UK in exporting services might be overstated as a consequence of recently discovered discrepancies between services trade statistics as recorded by the national statistical institutes of the UK and its main trading partners.[27] This may also have led us to overstate the importance of domestic value added in UK exports. At the time of writing, the nature and scale of the mismeasurement are unknown, because major bilateral discrepancies have been found for services imports as well as services exports. It is thus unclear at this stage whether improvements in the data would lead us to revise our estimates of the domestic value added share in UK exports upwards or downwards, and to what degree.

In addition to the fact that the benefits of leaving the Customs Union might be limited, there is a risk that increased barriers between the UK and the EU will threaten the UK's participation in value chains that already supply rapidly growing demands in emerging markets.

Survey evidence points to the possibility that Brexit may disrupt cross-border supply chains between the UK and the EU. A survey by the Chartered Institute of Procurement & Supply (2017) found that 32 per cent of UK supply chain managers who worked with EU suppliers were preparing for Brexit by looking for alternative suppliers within the UK (21 per cent were looking for suppliers outside the EU). The same survey also found that 46 per cent of European supply chain managers with links to the UK expected to reduce their use of UK suppliers, with 28 per cent expecting to 're-shore' all or part of their supply chain to the EU. In light of this, tracing the impact of any change in

[27] See Office for National Statistics (2018).

UK–EU trade barriers on the UK's position in global value chains is likely to be an important area for future research.

Supporting information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

- Appendix

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